MORA RIVER
(USGS GAGE EAST OF SHOEMAKER TO HWY 434)
NUTRIENT/EUTROPHICATION BIOLOGICAL INDICATORS
IMPAIRMENT DETERMINATION
FOR THE
2004-2006 CLEAN WATER ACT INTEGRATED §303(D)/ §305(B)
LIST OF ASSESSED WATERS

Prepared by

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1.0 NUTRIENT ASSESSMENT HISTORY

1.1 Background

While a few streams have segment specific numeric criteria, New Mexico currently has no general numeric criteria for nutrients. The narrative criterion found in Section 20.6.4.12(E) *State of New Mexico Standards for Interstate and Intrastate Surface Waters* states (NMWQCC 2001):

> *Plant Nutrients: Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in a dominance of nuisance species in surface waters of the state.*

SWQB has developed a protocol to determine if a stream reach is meeting this criterion (Appendix A). This protocol was expanded in recent years to include additional indicators with numeric translators. If an assessment unit is determined to be impaired based on this protocol, it will be noted as a Category 5 (i.e., "303[d]") water on the Integrated Clean Water Act (CWA) §303(d)/§305(b) List of Assessed Waters.

The nutrient assessment protocol is a dynamic document that will be refined as more data are collected, enabling more precise classification of streams and definition of relationships between nutrient concentrations, indicators, and impairment in New Mexico streams. SWQB is also in the beginning stages of a CWA 104(b)(3) project to refine numeric indicators and develop nutrient criteria.

1.2 Objective

Concern for potential nutrient impairment in the Mora River (USGS gage east of Shoemaker to HWY 434) has been noted in the past based on visual observation. The Mora Mutual Domestic Water and Sewerage Works wastewater treatment plant (WWTP) discharges into this reach. The Mora National Fish Hatchery and Technology Center also discharges a portion of their effluent into this reach (via an unnamed tributary and Tambley Ditch). The portion of effluent that contains nutrients goes through a supper micro filtration process and evaporation pond, and is not discharged to the Mora River.

The WWTP and the NMED Construction Program Bureau have identified potential funding sources for plant upgrades. A variety of indicators listed in the protocol were collected in 1999, 2002, and 2004 in order to determine potential nutrient impairment in the Mora River. SWQB completed a nutrient impairment assessment of the Mora River in order to provide information needed for potential plant improvements. The data generated during the nutrient assessment will also be used to develop any subsequent Total Maximum Daily Load (TMDL) planning documents. Since the WWTP discharges into this reach, the TMDL will include a waste load allocation (WLA).

2.0 IMPAIRMENT EVALUATION

2.1 Nutrient assessment

The potential for excessive nutrients in the Mora River were first noted through visual observation. To address this concern, data collected during 1999, 2002, and 2004 from seven stations in the assessment unit were collated and applied to the nutrient assessment protocol. Total nitrogen values were above the Southern Rockies ecoregion criteria of 0.30 mg/L in >15% (48%) of the samples, total phosphorus values were above the ecoregion criteria of 0.0.025 mg/L in >15% (28%) of the samples, and the percent dissolved oxygen (DO) saturation was greater than 120% in >15% (51%) of the samples. Chlorophyll *a* and ash free dry mass (AFDM) samples collected at the station above the WWTP exceeded numeric thresholds detailed in the nutrient assessment protocol as well. Since three or more indicators were present above threshold values, the reach was determined to be Not Supporting for Nutrient/Eutrophication Biological Indicators.

This water will be listed as Category 5C to acknowledge that additional data is needed. The U.S. Geological Survey (USGS) is in the process of refining proposed ecoregion total nitrogen and total phosphorus values for New Mexico. Also, fisheries data, information specific to designated uses of the reach, and additional chlorophyll *a* and AFDM data is needed to support the listing determination and provide data for TMDL development.

2.2 Assessment Conclusions and Proposed Changes to 2004 Integrated List

Based on the above assessment of the Mora River, the following changes will be made to the 2004 CWA Integrated §303(d)/§305(b) List of Assessed Waters:

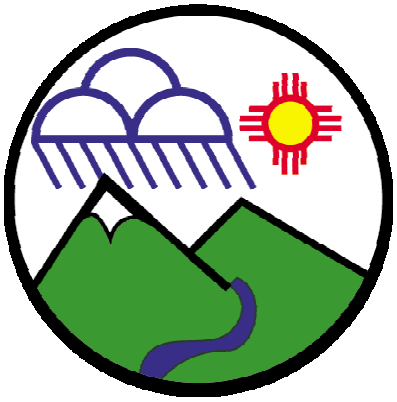
- Mora River (USGS gage east of Shoemaker to HWY 434) will be noted as Not Supporting for Nutrient/Eutrophication Biological Indicators. The assessment unit will be noted as Category 5C to acknowledge that additional data is needed and being collected.

APPENDIX A:

GUIDANCE FOR NUTRIENT ASSESSMENTS OF STREAMS

(SWQB Last Revised May 2004)

GUIDANCE FOR NUTRIENT ASSESSMENTS OF STREAMS



New Mexico Environment Department
Surface Water Quality Bureau

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May 2004

DRAFT

Purpose

This document establishes an assessment protocol for determining nutrient impairment status of wadeable streams. While a few streams have segment specific numeric criteria, New Mexico currently has no general numeric criteria for nutrients. The narrative criterion in *State of New Mexico Standards for Interstate and Intrastate Surface Waters* states that, "Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in a dominance of nuisance species in surface waters of the state" (NMWQCC 2002). This protocol will be used to determine if a stream reach is meeting this criterion. If an assessment unit is determined to be impaired, it will be added to the 303(d) List of Impaired Waters and a TMDL will be written. This protocol is a dynamic document that will be refined as more data are collected, enabling more precise classification of streams and definition of relationships between nutrient concentrations, indicators, and impairment in New Mexico streams.

Background

The presence of some aquatic vegetation is normal in streams. Algae and macrophytes provide habitat and food for aquatic organisms. However, excessive aquatic vegetation is not beneficial to most stream life and may change the aquatic community structure. High nutrient concentrations may promote an overabundance of algae and floating and rooted macrophytes. The types and amounts of aquatic vegetation often reflect the level of nutrient enrichment. Algae are either the direct (excessive periphyton mats or surface plankton scums) or indirect (diurnal swings of dissolved oxygen and pH and high turbidity) cause of most problems related to excessive nutrient enrichment. In addition, taste and odor problems in drinking water supplies are often caused by algal blooms. Blooms of certain types of blue-green (cyanobacteria) and golden (*Prymnesium* spp.) algae can produce toxins that are detrimental to animal and human health. One of the most expensive problems caused by nutrient enrichment is increased treatment required for drinking water.

Some increases in primary productivity can increase the abundance of invertebrates and fish in streams. However, excessive plant growth and decomposition can limit aquatic populations by decreasing dissolved oxygen (D.O.) concentrations. Plant respiration and decomposition of dead vegetation consume D.O. Lack of D.O. stresses aquatic organisms and can cause fish kills. Nocturnal respiration can cause oxygen depletion in waters with high primary productivity and low reaeration rates. Even relatively small reductions in D.O. can have adverse effects on both invertebrate and fish communities (USEPA 1991). Dissolved oxygen saturation levels of greater than 120% may be harmful to aquatic life (Behar 1996). Development of anaerobic conditions will alter a wide range of chemical equilibria and may mobilize certain pollutants and generate noxious odors (USEPA 1991).

The variables referred to in this document are measurable water quality parameters that can be used to evaluate the degree of eutrophication in streams. The variables consist of

causal variables (nutrient concentrations), and response variables (algal biomass, pH, and D.O.). Relationships between these variables are not as tightly coupled in rivers and streams as they are in lakes. Many other factors come into play in lotic systems, including flow regime, channel morphology, bed composition, degree of shading, and grazing by invertebrates. Many of these factors will be noted during the nutrient survey to aid in interpretation of measured variables.

The highly variable flows and spatially interrupted nature of many streams in arid landscapes can have great influence on both nutrient loading and biomass production. In the arid southwest, low and middle elevation streams may have naturally high levels of productivity due to the long growing season, high temperatures, open canopy and the resulting tight cycling of available nutrients (AZDEQ 1996, Fisher and Grimm 1983).

Assessment Procedure

The primary question to be answered is: **Is this reach impaired due to nutrient enrichment?** Nutrient impairment occurs where algal and/or macrophyte growth interferes with designated uses, thus preventing the reach from supporting these uses. Algal biomass is the most important indicator of nutrient enrichment, as algae cause most problems related to excessive nutrient enrichment. Algae and macrophytes may be a nuisance when 1) there are large amounts of rotting algae and macrophytes in the stream; 2) the stream substrate is choked with algae; 3) large diurnal fluctuations in D.O. and pH occur; and/or 4) there is a release of sediment-bound toxins.

This protocol uses a two-tiered approach to nutrient assessment. The two levels of assessment are used in sequential order to determine if there is excessive nutrient enrichment. If a Level I assessment indicates nutrient enrichment, a Level II assessment will be used to test this finding and provide more quantitative indicators. Level I is a screening level assessment that is observational with limited measurements. It is based on a review of available data, including on-site observations and measurements of chemical parameters. Level II is based on quantitative measurements of selected indicators. If these measurements exceed ecoregion numeric nutrient criteria, indicate excessive primary production (i.e., large D.O. and pH fluctuation and/or high chlorophyll *a* concentration), and/or demonstrate an unhealthy benthic community, the reach is considered to be impaired. Both assessments use data that are collected during water quality and nutrient surveys and compiled on the Nutrient Survey Forms. These data, along with reports from the SWQB in-house water quality database, are used to complete the Nutrient Assessment Form and conduct the assessment.

In February of 2002, EPA released nine nutrient water quality criteria documents. These documents contained EPA's recommended criteria for total phosphorus (TP) and total nitrogen (TN) for aggregate ecoregions. The criteria were derived using procedures described in the Rivers and Streams Nutrient Criteria Technical Guidance Manual (USEPA 2000a) (http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/rivers/index.html). These aggregate ecoregion nutrient criteria were intended as a starting point for states and

authorized tribes to develop more refined nutrient criteria. Evan Hornig, a USGS employee, is assisting states in EPA Region 6 to develop nutrient criteria. He used regional nutrient data to derive criteria for Level III ecoregions in New Mexico using site medians and EPA procedures. These Ecoregion Nutrient Criteria for streams, shown in Table 1, will be used in the nutrient assessment. These criteria will continue to be refined as the New Mexico nutrient dataset grows and a higher resolution stream classification is developed.

Table 1. **Ecoregion Nutrient Criteria** for streams (mg/L), calculated using site medians and EPA procedures (Evan Hornig, unpublished data 2003)

	Southern Rockies	AZ/NM Mountains	AZ/NM Plateau	Chihuahuan Desert	SW Tablelands	Madrean Archipelago
TN	0.30	0.32	0.42	0.64	0.54	0.25
TP	0.025	0.020	0.070	0.062	0.025	0.105

SWQB has adopted a multi-indicator approach to conduct a more robust assessment and account for diverse lotic systems and dynamic nutrient cycling. Cause and response variables are both used. It is important to incorporate response variables into the assessment as ambient water column nutrient "concentrations cannot indicate supply because large biomass of primary producers may have a very high nutrient demand and render inorganic nutrient concentrations low or below detection" (Dodds and Welch 2000). The response variables of algal biomass, D.O., and pH are incorporated into the assessment. For D.O. concentration and pH, criteria are based on designated uses of an assessment unit, as indicated in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMWQCC 2002) (Table 2).

Table 2. Criteria for dissolved oxygen concentration and pH

Designated Use	Dissolved Oxygen	pH
High Quality Coldwater Fishery	6.0 mg/L	6.6 – 8.8
Coldwater Fishery	6.0 mg/L	6.6 – 8.8
Marginal Coldwater Fishery	6.0 mg/L	6.6 – 9.0
Warmwater Fishery	5.0 mg/L	6.6 – 9.0
Limited Warmwater Fishery	5.0 mg/L	6.6 – 9.0

The assessment may use either a reference or criteria approach (USEPA 2000). For most streams, indicators will be compared to thresholds from published literature. If, however, the researcher feels that these thresholds are not appropriate for the class of stream being assessed, a reference site approach will be used. A suitable reference reach will be surveyed and indicators from the study reach will be compared to those of the reference reach rather than established thresholds. This is to account for streams that may have naturally high productivity because of regional geology, flow regime, or other natural causes.

Level I Nutrient Assessment

Level I Nutrient Assessment will use water quality data and field observations that have been compiled for each assessment unit. Data from the SWQB database, field sheets, and other readily available sources (such as USGS and NPDES permittees) should be utilized. These data are compiled on the Level I Nutrient Survey Form and used to complete the Level I Assessment Form. This assessment should be conducted in late August, just prior to the nutrient and benthic macroinvertebrate index period (September and October). The Level I assessment will be conducted at this time to utilize as much water quality survey data as possible and leave enough time to conduct the Level II Nutrient Survey at those sites that the Level I Assessment indicates the need. The following parameters are used in the Level I assessment(if two or more of these observations indicate nutrient enrichment, a Level II Assessment should be conducted).

Algae and Macrophyte Coverage:
Macrophyte is a general term that applies to many types of aquatic vegetation including flowering vascular plants, mosses, and ferns. Nutrients supplied from sediments combined with those in solution are usually adequate to meet nutritional demands of rooted aquatic plants, even in oligotrophic systems (Barko and Smart 1986). Macrophyte growth in streams is usually controlled by temperature, substrate characteristics, light limitation, or flow regimes. Phosphorus, nitrogen, and other nutrients may be taken up by submerged macrophytes from sediment, uncoupling rooted macrophyte growth from water column nutrient concentrations (Welch 1992). As bottom sediments act as the primary nutrient source for rooted macrophytes, they will not be used as indicators of nutrient enrichment. However, abundance of rooted macrophytes will be noted during nutrient surveys to explore their relationships with other variables.

Algae are non-vascular plants without true roots, stems, or leaves. They are mostly aquatic and range from tall stalks of kelp to fuzzy growths of green filamentous algae to microscopic, silica-encased diatoms. In the context of this document, algae refers to the visible growth of non-rooted aquatic vegetation attached to the stream substrate. The extent of algal coverage of a streambed can be an important indicator of algal biomass problems (USEPA 2000). As nutrient enrichment increases, the percent of streambed covered with algae increases (Welch et al. 1987, Lohman et al. 1992, Biggs 1996). The Level I assessment uses percent algal coverage as a qualitative indicator of algal biomass. A visual estimate of the percent of both algal and macrophyte coverage will be recorded. Generally, this will be determined at each site once in the spring, summer, and fall as part of SWQB water quality surveys. Coverages of greater than 50% in any season may indicate nutrient enrichment. On the Nutrient Assessment Form, indicate if this 50% threshold is exceeded during any season.

Periphyton Abundance: Periphyton is an assemblage of organisms that grow on underwater surfaces and includes a complex matrix of algae and heterotrophic microbes including bacteria, fungi, protozoa, and other organisms (Allaby 1985). Periphyton is composed primarily of microscopic organisms, while algae noted in the percent coverage

is mainly macroalgae. The extent of periphyton coverage of a streambed can be an important indicator of algal biomass problems (USEPA 2000). A rating of periphyton abundance will be recorded during the nutrient survey. The rating is from 0 to 5 as follows: **0)** rough with no apparent growth; **1)** thin layer of periphyton is visible (tracks can be drawn in the film with the back of your fingernail); **2)** 0.5 to 1 mm thick; **3)** 1 to 5 mm thick; **4)** 5 to 20 mm thick; and **5)** >20 mm thick. Periphyton thickness of >l mm (rating of >2) may indicate nutrient enrichment. On the Nutrient Assessment Form, indicate if the rating is greater than 2 during any season.

Anaerobic conditions: Anaerobic conditions can be indicative of excessive plant growth and decay. Decomposition of organic material uses oxygen, and excessive decomposition can create anoxic conditions. Anaerobic decomposition that takes place in anoxic conditions produces hydrogen sulfide with an associated "rotten egg" smell and black color. Note if an anoxic layer is found under rocks and/or in depositional areas.

Dissolved Oxygen and pH: High rates of primary production can cause D.O. supersaturation and high pH during the day. Photosynthesis and respiration alter the amount of CO_2 in water, which affects pH. Photosynthesis removes CO_2 from water, which forces buffers to remove hydrogen ions, increasing pH. Respiration takes place at night (when photosynthesis does not occur) and adds CO_2 to water resulting in an increase in the number of hydrogen ions, thereby lowering the pH. Diurnal pH fluctuation will be greater in streams with low buffering capacity, so this may not be a responsive indicator in many NM streams. Dissolved oxygen deficit and high pH are the algal related problems most affecting aquatic life (Dobbs and Welch 2000). Unfortunately, it is difficult to test for D.O. deficit, as it usually occurs in the early morning after respiration has been occurring all night. Thus, D.O. percent saturation, which typically peaks in late afternoon, will be used as an indicator in the Level I Assessment. Note if any D.O. saturation readings are above 120%. Determine if any pH readings exceed 8.8 for high quality coldwater and coldwater fishery uses and 9.0 for marginal coldwater and warmwater fishery uses.

Water Chemistry: Print out and attach the Nutrient Report from the SWQB water quality database. Use the data in the report to calculate the exceedence ratio for TN and TP. The exceedence ratio is the number of times that the TN or TP concentration is above the ecoregion nutrient criteria (see Table 1.), divided by the total number of samples in the data set. Record the exceedence ratios for the entire dataset on the Level I nutrient Assessment Form. An exceedence ratio of >15% may indicate nutrient enrichment (SWQB/NMED 2004)

Level II Nutrient Assessment

A Level II Assessment is based on quantitative measures of indicators. It is conducted if the Level I Assessment indicates potential nutrient impairment. The Level II Assessment uses data that will be collected during a Level II Nutrient Survey and compiled on the Level II Nutrient Survey Form.

Diurnal Cycles: Algal biomass above nuisance levels often produces large diurnal fluctuations in D.O. and pH. Photosynthesis and respiration by dense algal mats commonly cause water quality criteria exceedences. The magnitude of diurnal swings in D.O. and pH will depend on several factors, such as turbulence (which affects reaeration), light, temperature, buffering capacity, and the amount and health of algal and/or macrophyte biomass. Higher temperatures tend to enhance algal growth in many streams and may increase photosynthesis and respiration resulting in greater variation in diurnal D.O. and pH values.

Use hourly readings of D.O., pH, specific conductance, temperature, and turbidity from the multiple day data set collected with a multi-parameter meter (sonde). For this assessment, use a data set that ends and begins at the same time of day, so only full days (24-hour periods) are counted. Observe pre-dawn measurements for minimum D.O. concentrations and afternoon hours for maximum pH and maximum D.O. percent saturation. Aquatic organisms are most affected by maximum pH and minimum D.O., rather than by daily means of these variables (USEPA 2000). Frequency, duration, and magnitude of the exceedence are noted to help define the severity of impairment and identify anomalies in the dataset (for example, readings taken when drifting algae had caught on the probes).

1) Note the time and location of Sonde deployment.
2) Note if the local D.O. percent saturation exceeded 120%. If so, note the number of days that an exceedence occurred, the maximum percent saturation, and the range in hours/per day that 120% was exceeded.
3) Note if the pH exceeded appropriate criteria. If so, note the number of days, the maximum pH, and the range in hours/per day that the pH exceeds criteria.
4) Note if the D.O. concentration falls below the appropriate criteria. If so, note the number of days, the minimum, and the range in hours/per day that D.O. was below the criteria.

For example, if a sonde was deployed for 5 days and exceeded 120% saturation for 2 readings on the 1st day, did not exceed on the 2nd day (because it was cloudy), then exceed for 3 readings on the 3rd and 4th days and for 4 readings on the 5th day with a maximum of 185%, one would fill out the Nutrient Assessment Form in the following manner for D.O. saturation and a similar manner for pH and D.O. concentration:

Table 3. Example of how to fill out the sonde portion of the Assessment Form.

Exceeds 120% **DO Saturation**? *YES*	If yes, # of days exceeded/total: *4/5*
Duration (range in hours/day): *2 - 4*	Maximum **DO % saturation**: *185*

Dissolved oxygen concentration, D.O. percent saturation, and pH are all used as indicators of nuisance levels of algal biomass. For D.O. percent saturation, a threshold of 120% is used. The criteria for D.O. concentration and pH are based on designated use (see Table 2). For D.O., the criterion is 6 mg/L for coldwater fisheries and 5 mg/L for warmwater fisheries. The threshold value for pH is 8.8 for high quality coldwater and coldwater fishery uses and 9.0 for marginal coldwater and warmwater fishery uses. If an assessment unit has both warmwater and coldwater uses, use the more stringent criterion to be protective of this use. An exceedence of any of these criteria for more than one hour on more than one day may indicate impairment.

If a sonde was not deployed for multiple days, use field data from the water quality survey to calculate an exceedence ratio for pH and D.O. percent saturation (Table 2). An exceedence ratio of greater than 15% may indicate nutrient enrichment (SWQB/NMED 2004). Sondes will not be deployed if there is a high risk of damage to, or loss of, the instrument due to high flows or vandalism.

Water Chemistry: Use the nutrient report from the SWQB water quality database. Print and attach a current report so that all available data are used. Record the TN and TP concentrations collected during the nutrient survey as well as the exceedence ratio for the entire dataset. The nutrient concentration measured during the survey will be used to define relationships with response variables (USEPA 2000). The exceedence ratio is the number of times that the TN or TP concentration is above the ecoregion nutrient criteria (Table 1), divided by the total number of samples in the dataset. An exceedence ratio of >15% may indicate nutrient enrichment (SWQB/NMED 2004).

Algal Sampling: In streams, benthic algae production and biomass are the most useful parameters in monitoring changes in water quality (USEPA 1991). Chlorophyll *a* concentration is used as a surrogate for algal biomass and is generally the most appropriate variable to monitor (USEPA 2000). Chlorophyll *a* is specific to algae, while Ash Free Dry Mass (AFDM) includes all living and non-living organic matter. Record the results of chlorophyll *a* concentration and AFDM analysis of benthic algae/periphyton samples. The units of the results must be in $\mu g/cm^2$. If more than one chlorophyll *a* or AFDM measurement was taken, record the average for each site visit. Do not average samples taken on different days.

In *Rapid Bioassessment Protocols (RBP) for Use in Streams and Wadeable Rivers* (USEPA 1999), nuisance levels of algal biomass are defined as: greater than 10 micrograms chlorophyll *a* per square centimeter (>10 $\mu g/cm^2$) and greater than 5000 micrograms AFDM per square centimeter (>5000 $\mu g/cm^2$). EPA's *Nutrient Criteria Technical Guidance Manual for Rivers and Streams* lists a number of algal biomass criteria ranging from 100 – 200 mg/m^2 (10 to 20 $\mu g/cm^2$) (USEPA 2000). The RBP

criteria will be used until SWQB is able to define region-specific values. Note if chlorophyll *a* and AFDM exceed these criteria.

The ratio of AFDM to chlorophyll *a* (AFDM/chl *a*) is termed the autotrophic index for periphyton and is used to distinguish the relative response to inorganic (N and P) and organic (BOD) enrichment (USEPA 2000). Periphyton growing in surface water that is relatively free of organic matter contains approximately one to two percent chlorophyll *a* by weight. Surface water that is high in particulate organic matter may support large populations of bacteria, fungi, and other non-chlorophyll bearing microorganisms, and have a larger ratio of AFDM to chlorophyll *a*. Increased ratios indicate that heterotrophs utilizing organic substances comprise a larger percentage of AFDM than autotrophic periphyton that rely largely on inorganic nutrients to increase biomass (Weber 1973). Ratios of AFDM/chl *a* can vary over three orders of magnitude, with values >400 indicating organically polluted conditions (Collins and Weber 1978). Ratios of AFDM/chl *a* around 250 are more typical for streams enriched with inorganic nutrients that are likely to have existing or potential eutrophication problems (Watson and Gestring 1996, Biggs 1996). The autotrophic index should be used with caution, because non-living organic detrital material may artificially inflate the ratio.

Benthic Macroinvertebrates: Samples of benthic macroinvertebrates should be collected from the reach being characterized and a suitable reference site. Indices employing macroinvertebrates as indicators of nutrient pollution have great potential. The benthic community will be assessed using the currently accepted NMED assessment protocol. This benthic macroinvertebrate index of biological integrity (M-IBI) uses a number of metrics (e.g. number of taxa, percent EPT-mayflies, stoneflies, and caddisflies, percent predators, etc.). The advantages of the M-IBI include low variability, high sensitivity, and absolute background values for a no effect condition (USEPA 2000). The M-IBI is considered to be representative of a functioning, sustainable biological assemblage, that is not beyond the natural range of reference conditions, when it is at least 80% of the reference score (SWQB/NMED 2004). In addition to the M-IBI, which is based on comparisons to a reference site, the assessment will also use the Hilsenhoff Biotic Index (HBI), which is based on tolorance of organisms to organic and nutrient pollution. An HBI value above 5.5 may indicate nutrient enrichment (Hilsenhoff 1987).

Algal Bioassays: If stream observations indicate that algal biomass may be a problem and/or there is an NPDES permit that discharges within the assessment unit, a limiting nutrient analysis and algal growth potential test may be performed. Currently, researchers at the University of New Mexico (UNM) are conducting these analyses for SWQB.

The procedures for determining limiting nutrients and algal growth potential are outlined in The *Selenastrum capricornutum* Prinz Algal Assay Bottle Test (USEPA 1978) and Biostimulation and Nutrient Assessment Workshop (USEPA 1975). Results are given in dry weight measurements in accordance with the EPA procedure. Dry weight is used to define the Productivity Classification as described in Table 4.

Table 4. Productivity Classifications from algal bioassay results.

Algal Growth (mg dry wt./L)	**Classification**
0.00 – 0.10	Low Productivity
0.11 - 0.80	Moderate Productivity
0.81 – 6.00	Moderately High Productivity
6.10 – 20.00	High Productivity

Moderately High Productivity and High Productivity may be indicative of nutrient enrichment.

Analysis and Interpretation: Compare each indicator to the associated criterion. Note those that exceed the criteria. If three or more indicators exceed the criteria, the assessment unit is determined to be not supporting.

If the study reach is believed to have naturally high productivity because of geology, flow regime, or other natural factors, a reference site approach may be used. Identify an appropriate reference reach for the study area and conduct a Level II Nutrient Survey of the reference reach near the same time that the study reach is surveyed. Whenever possible, select an existing survey site as a reference, as existing sites will have associated water quality data. Compare the indicators of the two sites, including algal biomass, benthic community composition, and chemical and physical parameters. Use statistical testes to determine significant difference where feasible. If indicators from the sites are in the same range, the assessment unit will not be listed. If, however, two or more of the indicators are substantially different, the assessment unit will be determined to be not supporting.

Level I Nutrient Assessment Form

Assessment Unit:	
Site Location:	
Assessment date:	Ecoregion:
Evaluator:	Fishery Uses:

Algae and Macrophytes: mark **True** if the indicator is present during one or more seasons.

Percent algal cover is greater than 50%: True False
Percent macrophyte cover is greater than 50%: True False

Periphyton and Substrate: mark **True** if the indicator is present during one or more seasons.

0 - rough with no apparent growth, **1 -** thin layer of periphyton is visible, **2 -** thickness of 0.5-1 mm, **3 -** 1 mm to 5 mm thick, **4 -** 5 mm to 20 mm thick, **5 -** >20 mm thick
Rating of the periphyton on coarse substrate is >2: True False
Anoxic layer present (black, H_2S layer): True False

D.O. Percent Saturation and pH: mark **True** if the indicator is present at any time
The pH criterion is 8.8 for high quality coldwater and coldwater fishery (CWF)uses, and 9.0 for marginal coldwater and warmwater fishery (WWF) uses.

D.O. percent saturation (local) is greater then 120%: True False
pH value is greater then 8.8 for CWF or 9.0 for WWF: True False

Water Chemistry: attach nutrient report from SWQB database.

Total Nitrogen **(mg/L):**	Total Phosphorus **(mg/L):**
Ecoregion Criteria:	Ecoregion Criteria:
Exceedence Ratio:	Exceedence Ratio:

Move to a Level II Assessment if two or more of the following occur:

- ____ Algae cover on stable substrate is >50%
- ____ Periphyton rating is >2
- ____ Anoxic layer is present
- ____ D.O. percent saturation (local) is greater then 120%
- ____ pH value is greater then appropriate criterion
- ____ Total nitrogen is above the ecoregion criterion or exceedence ratio is >15%
- ____ Total phosphorus is above the ecoregion criterion or exceedence ratio is >15%

Conduct Level II Assessment: Yes No

Level II Nutrient Assessment Form

Sonde: Attach tables or graphs of D.O. concentration, local D.O. percent saturation, and pH. For D.O., the criterion is 6 mg/L for coldwater fisheries and 5 mg/L for warmwater fisheries. The pH threshold value is 8.8 for high quality coldwater and coldwater fishery uses and 9.0 for marginal coldwater and warmwater fishery uses.

Date and time deployed:	**Date and time retrieved:**
Site Location:	
Exceeds 120% **D.O. Saturation**?	If yes, # of days exceeded/total:
Duration (range in hours/day):	Maximum **D.O. % saturation**:
Exceeds **pH** criteria?	If yes, # of days exceeded/total:
Duration (range in hours/day):	Maximum **pH**:
Falls below **DO** criteria?	If yes, # of days exceeded/total:
Duration (range in hours/day):	Minimum **D.O. concentration (mg/L)**:
Notes:	

Nutrient Survey Water Chemistry : attach updated nutrient report from SWQB database.

Total Nitrogen **(mg/L)**	Total Phosphorus **(mg/L)**
Result of nutrient survey:	Result of nutrient survey:
Total Exceedence Ratio:	Total Exceedence Ratio:
Notes:	

Algal Sampling:

Chlorophyll *a* (µg/cm^2):	Ash Free Dry Mass (µg /cm^2):
Exceeds criterion (10 µg/cm^2)? Yes No	Exceeds criterion (5000 µg /cm^2)? Yes No
AFDM/chlorophyll *a* ratio:	
Notes:	

Benthic Macroinvertebrates:

Date:	Sample method:
Reference site:	
Hilsenhoff Biotic Index (HBI):	
M-IBI Score (percent of reference):	
Notes:	

Algal Bioassays: Attach results.

Date collected:	Limiting nutrient:
Algal productivity: low moderate moderately high high	
Notes:	

Level II Assessment using Threshold Values

An Assessment Unit will be determined to be not supporting if **three or more** of the following indicators are present (if not all of the indicators have been measured, the presence of two of the following indicators may be assessed as not supporting).

- ____ D.O. percent saturation is greater than 120% for > 1 hour on more than 1 day
- ____ pH value exceeds appropriate criteria for > 1 hour on more than 1 day
- ____ D.O. concentration falls below appropriate criteria for > 1 hour on more than 1 day
- ____ Total nitrogen is above the ecoregion criterion in >15% of samples
- ____ Total phosphorus is above the ecoregion criterion in >15% of samples
- ____ The Algal Bioassay indicates moderately high or high algal production
- ____ Chlorophyll *a* concentration is greater than 10 μg/cm^2
- ____ AFDM is greater than 5000 μg /cm^2
- ____ HBI is greater than 5.5
- ____ M-IBI Score is less than 80% of reference

Fully supporting	**Not supporting**
Notes:	

Notes

Total Nitrogen is calculated by adding Total Kjeldahl Nitrogen plus Nitrate + Nitrite. In the event that Nitrate + Nitrite or Total Kjeldahl Nitrogen are below the detection limit, a value of one half the detection limit will be used (Gilbert 1987).

Put NA (not available) in boxes for parameters that were not collected.

Ecoregion based **Stream Nutrient Criteria** (mg/L) (Evan Hornig, unpubl. data 2003) (calculated using site medians)

	Southern Rockies	AZ/NM Mountains	AZ/NM Plateau	Chihuahuan Desert	SW Tablelands	Madrean Archipelago
TN	0.30	0.32	0.42	0.64	0.54	0.25
TP	0.025	0.020	0.070	0.062	0.025	0.105

Level II Assessment using a Reference Site

An Assessment Unit will be determined to be not supporting if **two or more** of the following indicators of the study site are notably different from those of the reference site:

Indicator	Reference Site	Study Site
D.O. saturation exceedence ratio*		
pH exceedence ratio*		
DO concentration exceedence ratio*		
Total nitrogen exceedence ratio		
Total phosphorus exceedence ratio		
Chlorophyll *a* concentration		
AFDM		
HBI		
M IBI Score % of reference	100	
Algal Bioassay algal production		

* the exceedence ratio here refers to the number of days with exceedences over the number of full days that the sonde was deployed, not the number of readings

Fully supporting	**Not supporting**
Notes:	

Notes

Put NA (not available) in boxes for parameters that were not collected.

Complete a Level II Assessment Form for the reference site.

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